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ABSTRACT

In an attempt to unearth the characteristic communication practices of mathematical seminars, the perceptions and beliefs about them held by regular attendees, and the normative ideals about communication in the mathematics community, this paper considers how communication in math is an integral part of how mathematicians do their work. Responding to Karen Tracy's study of intellectual discussion "Colloquium: Dilemmas of Academic Discourse", the paper argues that the construction of "equality through expertise" is the major belief affecting seminar practices and discussion in mathematics. This belief contributes to a portrait of the math world and the academy in general. Examining mathematical seminars, thus, expands notions about intellectual discussion in the academy and challenges notions about the dichotomy between the cognitive sciences and the social sciences. The math community's definitions of interplay of equality and expertise are developed. Briefly describing the role of seminars in mathematics generally and at the ethnographic site, the data is described, and the method used to gather and analyze it is explained. The paper discusses the participants and regular seminar attendees studied and outlines how they described the atmosphere of their seminars, especially with regard to the culture of mathematics, seminars in the math department, and seminars in science. (Contains 30 references and 36 endnotes.) (ASK)

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Intellectual Discussion in Mathematics

Christina Cavaluzzi

NCA Conference
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Panel : "The Pressure of Performance"

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Communication in math is an integral part of how mathematicians do their work. Gatherings like seminars and colloquia occur in math departments frequently. Because they are omnipresent and customary, seminars represent one important site of acculturation into the mathematical community. Seminars seem to be so much a part of regular mathematical life that they are accepted and attended without question. In addition to providing a site for novices to observe and learn how to act in seminar, they also demonstrate the community's communicative and epistemological norms and practices.

The research presented in this paper was conducted in response to Karen Tracy's study of intellectual discussion, Colloquium: Dilemmas of academic discourse.[1] By expanding to a different ethnographic site within the academy, themes and practices unique to another intellectual tradition are revealed, extending Tracy's definition of academic discourse and intellectual discussion. Towards that end, this research has tried to unearth the characteristic discourse practices of mathematical seminars, perceptions and beliefs about them held by regular attenders, and the normative ideals about communication in the mathematics community. The construction of "equality through expertise" is argued to be the major belief affecting seminar practices and discussion in mathematics, and one of the most interesting feature to challenge Tracy's conception of intellectual discussion.

Tracy uses Bateson's notion of a situational frame (Bateson 1972, after Tracy 1997, p. 6) to guide her analysis of colloquium as intellectual discussion. Her definition of intellectual discussion is based on interviews with her informants:

> Most basically, intellectual discussion is a talk occasion in which the primary focus is on ideas. Furthermore, the ideas are ones of some abstraction...In addition, participants are expected to explore differences of opinion when, at least in principle, they are open to changing their minds as a result of talking. Finally, the occasion is valued as an end in and of itself, not simply as a tool to be used to accomplish other ends such as making a decision, or teaching information to another.[2]

She selected to study the departmental colloquium because it is a site where "academics "do" intellectual discussion" and because it is a place where "talk enacts identities."[3] She contrasts this frame, and her subsequent definition of "intellectual discussion," with other possible frames that have been used to define talk in the academy and intellectual discussion in the sciences. Grimshaw characterized talk from a dissertation defense as engaging in "professional talk".[4] McKinlay and Potter describe the intellectual discussion of psychologists at a conference as "science" talk.[5]

Tracy's department was Speech Communication where faculty and graduate students attended a single weekly seminar. In the mathematics department, a much larger department, each different sub-speciality holds separate weekly seminars. In the mathematical seminars, all three of these frames are

combined -- "doing science,"[6] "professional talk" and "intellectual discussion." As a result, distinctions between them seem arbitrary and meaningless, at least for this study. Clearly, talk in science is both professional and intellectual, indeed interviewees who participated in this study characterized it as such.

Then, it seems that the intellectual discussion frame may be challenged as it relates to the study of science. Many authors have found it convenient to dichotomize between these "two cultures."[7] Researchers who have turned a sociological or anthropological eye on science have focused primarily on the laboratory sciences, where the influences of the social system of science can be more easily observed as it relates to the production of knowledge and the influence of tacit knowledge.[8] Studies of mathematics that have offered linguistic or philosophical analyses have tended towards the internal aspects and logic of proofs, or the sociology of proof production and mathematical objects.[9]

The research in this paper, on the other hand, contributes to a portrait of the math world and the academy in general. In a place where "social talk and technical talk seem to be going on simultaneously and interchangeably,"[10] the math seminar offers a new location to observe part of the process of how mathematics is done. Because seminars are such a universal phenomenon in mathematics, they reveal some of the values and beliefs about communication and intellectual discussion held by the mathematical community, and perhaps those of the scientific community. Examining mathematical seminars thus expands notions about intellectual discussion in the academy and challenge notions about the dichotomy between the cognitive sciences and the social sciences.

Most strikingly, the equality-expertise dilemma that Tracy sees as inherent in academic discussion, plays out differently in math seminars. Tracy's "interviewees believed that some type of rough equality or at least absence of marked inequality was necessary for good discussion."[11] In her site, inequality specifically means institutional rank and status, and was found to be "a desirable feature of academic settings"[12] at the same time it influenced communicative behavior. In the mathematical seminar, interviewees did echo the

belief that ideas should be considered in terms of their merit, but did not express a tension that "ideas should be examined in terms of a speaker's experience level."[13] Rather, math seminar audience members felt that each presenter is an expert in the topic being presented, regardless of institutional rank or mathematical or presentational experience. Further, the speaker's right and interest in pursuing an idea should not be questioned or judged; instead, it is appropriate to question the clarity of the historical and mathematical motivation of an idea.

Another feature of the math world involved the relationship between equality of institutional rank and knowledge. For the Speech Communication Department, Tracy found that good discussion was believed to take place when participants possess roughly the same amount of knowledge about an area, but that lively, involved interchange occurs when everybody participates. In contrast, good mathematical discussion occurs when people possess knowledge about <u>different</u> areas of expertise. Equality was not gained in an absence of hierarchy, as Tracy's informants saw it; rather, equality is gained through mathematical expertise. This kind of expertise specifically ignores hierarchial rank, as the knowledge is specialized and considered difficult for one person to possess in all areas. Tracy states, "the hierarchy in academic institutions reflects individual differences in experience and accomplishments."[14] In mathematics, this is not necessarily so, and a belief of "equality through expertise" affects rules and roles of seminar presenters and audience members.

Roles of participation are perhaps the most obvious difference between the Communication Department Tracy describes and those observed in the math seminar. Instead of a belief that views "criticism as indicative of being taken seriously as a scholar"[15] leading to a pressure to ask interesting questions during colloquium, math seminar attenders did not feel pressure to participate verbally. One similarity between the two groups is that presenters in both fields were seen to do "work" in positioning themselves and their ideas. Math presenters, however, positioned themselves more often at the level of citation of other's and self's previous work and when work presented was "in progress." This kind of positioning served to construct an

identity particular to this community and related to its ideals about equality and expertise: that of the humble, careful mathematician.

In this paper I develop further the math community's definitions about the interplay of equality and expertise. A finding strikingly different to the equality/expertise dilemma that Tracy discusses in her work, I propose that an ideal of "equality through expertise" affects math discussion, especially in seminar. These ideals about equality of expertise are related to a commonly expressed belief about the difficulty of mathematics and an individual's expertise that seems to transcend institutional rank positions. Most particularly, because each seminar presenter possesses an expertise that no other audience member may share, all the mathematicians who participated in this research admitted they do not expect to understand all seminar presentations they attend and therefore they are under no pressure to participate verbally in order to understand.

The next section briefly describes the role of seminars in mathematics generally and at the ethnographic site. Then I describe the data and explain the method used to gather and analyze them, and the interview participants and seminar attenders. Finally I outline how the regular attenders of the seminar described the atmosphere of their seminars, especially in relation to the culture of mathematics and other seminars in the math department and other seminars in science. Their descriptions elucidate some of the values and beliefs about seminar behavior and discussion that I offer as examples in the following section.

Seminars in Mathematics and at the Ethnographic Site

Weekly seminars devoted to a specialized research area or topic are a common feature of university research Mathematics Departments. They exist worldwide and are often not officially institutionalized in terms of funding, scheduling or attendance policy. Compared to more formal presentations delivered to a

doctoral student's committee but open to the public, seminars are informal and attendance is voluntary. Students and faculty, as well as invited visitors from outside the department and university may present at seminars.

Fifteen seminars in a wide variety of pure mathematical topics met weekly at the research site in 1996-97. Four additional applied math seminars were offered in conjunction with other departments, and in 1997-8 an additional seminar was organized by and for graduate students. A weekly general colloquium also meets, "preceded by tea of course,"[16] designed for general math audiences and usually presented by a visiting mathematician. Teas are informal gatherings organized by the Department and funded by the Chairs to create a comfortable atmosphere for conversation and research. There are approximately 70 tenured and non-tenured professors and 130 graduate students in the Math Department, which is considered a major research center.

The seminars are not supported by departmental monies. They are organized by faculty (and graduate students in the one case) according to their research interests, and rise and fall based on these interests.[17] Faculty will often use grant money to pay for an outside speaker's travel expenses and these visits always include at least one seminar talk, and sometimes a colloquium talk (a presentation designed for a general math audience.)

Topics for the seminar are selected by the speakers. Although the seminar is overwhelmingly a place where original research results are presented, the speaker may present a paper that the group has selected as important to read. Presenters may also talk about some aspect of a problem in progress rather than a completed work. These presentations are not considered less important than presenting original research, as seminar is seen as a way to continue one's education and learning.

Faculty and graduate students who are interested in pursuing research in a particular field, as well as those who have already identified themselves with a research area or group, will commonly attend "their"

seminar regularly, although not all faculty who do research in a particular field will regularly attend the seminar. The purposes of seminar include learning new results and finding new ways to work on one's own problem or finding a collaborator. Making connections between people and ideas is one of the goals of seminars. Commonly, mathematics is done through an interplay of solitary work and talking with colleagues. Most prefer to talk face-to-face than read papers; this represents one of the community's normative ideals about how to get work done efficiently.[18]

The group or an individual faculty member may invite a speaker because they have heard about their latest result(s) and hope that their work and experience can offer insight or lead to a collaboration. During their stay, visitors usually meet with those who are interested in engaging in informal discussions about problems, both one's own work and that of the visitor.

Asking questions, both to oneself and to colleagues or collaborators, constitutes much of the way mathematics research is done. Thus, the role of community plays a critical role in the daily life of many research mathematicians. Often mathematicians will rely on their intuition to decide which tactic to pursue, or they can ask others for their intuition about how to solve a problem or about a particular tactic they have selected, as asking questions to different people is an important part of the process of solving a problem.

Seminars also serve a distinct social purpose -- in addition to creating group cohesion and identification, people learn what their colleagues are working on so they know who to go to for various questions they may have. Related to this notion of asking questions in doing math research is the practice called "talking math." Talking math occurs when 2 or more people talk about a concrete mathematical problem in an effort to solve it or to discuss how to begin to approach a problem. The most productive math talk occurs in an informal climate, when the people are genuinely interested in the topic, know a little bit about it and are willing to discuss it without condescending. In these situations, all participants are considered equals, regardless of hierarchial position, as experience and specific knowledge can reverse

"normal" rank relationships.

The connection between the communication part of doing math research and having seminars seems clear. Faculty agree that they attend seminars to hear about new results or to find collaborators, but they are also aware that they should ask questions so that graduate students also feel comfortable doing so, although they rarely do. An informal seminar atmosphere is desirable to the community, connected to an appreciation of how difficult math is, and the belief that novices will eventually be able to understand more than the first 10 minutes of a seminar if they persist in going, although faculty state they can still get confused.

As the following sections will describe, the norms of the community include an equality that exists in each person's expertise. In many cases during the seminar however, rank and hierarchy were maintained and established by participants, both through their participation and non-participation. But it was not a clear case of hierarchy being established and enforced by lower-status members of the community while those at the top reject it.[19] Both those at the top and the bottom reject that hierarchial positions should prevent people from feeling uncomfortable and apprehensive about asking questions.

Method and Description of the Seminars

The majority of the data presented in this study were gathered through participant-observation at two weekly topical seminars in The University of Texas Mathematics Department and interviews with some of their regular attenders. The interview participants represented the range of mathematical seminar experience. Five of the informants were women and seven were men. All informants appeared to be white, although they were not asked to describe their race or ethnicity. Two of the informants had not received their Ph.D.'s from a university in the United States. One informant was not a native speaker of English, but had completed graduate study in the United States. There was a striking similarity of responses regarding the purposes of seminar and definition of math talk that seemed to transcend age, experience, and educational origin, suggesting the existence of a shared culture of mathematics with shared values and practices.

I observed the seminars as a passive participant: I was "present at the scene of action but [did] not participate or interact with other people to any great extent."[20] I could not "engage in activities appropriate to the situation"[21] and could not ask questions during seminar because of my mathematical ignorance. However, not being able to ask questions because of a lack of understanding of the topic of a seminar presentation, does not mark an audience member as a non-participant. So in a sense, I was simply a participant observer.

In total, fourteen in-depth, ethnographic interviews, each lasting at least one and a half hours, were conducted and transcribed. In the text, excerpts from attenders of Seminar A are given pseudonyms beginning with the letter A, those from Seminar B are referred to with names beginning with B. In addition to attending these two seminars regularly and interviewing some of the regular attenders, I also attended numerous social functions and one day of the annual joint meeting of the Mathematical Association of America and the American Mathematical Society, as well as several other topical seminars in the math department on a one-time basis. Additional information about the history, status and organization of the Department was obtained through interviews and conversations with the current and a former chair of the Department, office staff members and other regular seminar attenders who were not interviewed formally.

Of the two seminars I regularly attended, one had been meeting at the same time and day for at least 20 years while the other had been meeting for at least eight years. At Seminar A, the number of audience members averaged between seven and fifteen and at Seminar B, average attendance varied from 15 to 20.

The seminars are scheduled to last one hour: approximately 50 - 55 minutes is devoted to an introduction of the problem, called "motivating the question," and presentation of some interesting details of the proof that is the topic of the presentation. Some time is allotted for questions during the hour, but there is generally little discussion during or after the talk as it is expected that those who are interested will stay after to talk with the presenter and the other people who are also interested.

The interview questions were adapted from Karen Tracy's book Colloquium: Dilemmas of academic

discourse.[22] The interviews were conducted as an interactive communicative situation, with a sensitivity to informants' responses and how I influenced the course of the interview. All the informants were familiar with a confidential interview situation. Interviewees were extremely forthcoming, friendly and willing to participate. Only one person refused an invitation to be interviewed.

I also followed Tracy's method of analysis, "Action-Implicative Discourse Analysis," to consider the interview responses, as well as the talk in interaction at the seminar, at broad and micro-levels of analysis. In addition, I have considered the descriptions and evaluations of intellectual discussion and talk in seminars related to me during the interviews as expressions of the normative ideals of the informants as individuals and as members of the mathematical community. In this way I have tried to combine "ethnographic material, participant attributes, and patterns of social organization that are constitutive of talk"[23] with participants' attitudes and their insights to study the structure of discourse in mathematics seminars.

Common in all the interviews conducted with participants in these two seminars was a favorable description of the seminar atmospheres as informal and relaxed, where the people are civilized, supportive, "a friendly bunch" who "don't harass you, they help you along." Most stated that they did not feel there was "much of a hierarchial structure" at seminar that affected how people saw them. This style and structure at seminar is related to a general ethos and collective "congenial" character of mathematicians.

The two seminars I attended were related in topic. At the same time that many felt that their seminar was unique compared to other seminars in the Department, many claimed that the presentational style was determined by the kind of mathematics studied. Many felt that I would find different seminar practices and atmospheres in other branches of mathematics, but felt that overall they were characterized by a style unique from other branches of the sciences. Physics was commonly contrasted with math to explain the politeness and congeniality of mathematicians and their seminars. Two seminar practices that informants attributed to this difference and believed physicists commonly practiced were not harassing speakers or backing them into

a corner with questions, and not leaving a seminar in the middle of a presentation.[24]

> See we're all very polite in mathematics. We sit and don't get up and walk out at talks, which in other subjects I think they do...But in mathematics conventionally...we think that's kind of rude...I'm actually complementing the physicists, I think we should do the same really sometimes, but in fact, you know, we all just sit there politely, and sit in the back row and just get on with our own stuff and look up every now and again. And when the guy finishes we clap and you go. That happens quite a lot I'm afraid. (Barry, senior faculty member)

Those mathematicians who violate this rule are seen as few and isolated, as well as brusque. These kind of responses were heard from informants at all stages of their mathematical experience, and although few had had any direct experience attending seminars in other fields of the sciences, the culture of Physics was overwhelmingly used as a yard stick to compare to mathematicians. One informant found that the difference may be in a hierarchy of status related to the competitiveness of research funding that characterizes the physical sciences, but not mathematics, and thus leaves mathematicians more even-tempered.

In the next section, ideals about equality and expertise are more fully explored and explained, especially in light of the implications for Tracy's definitions of academic, intellectual discussion. Then I offer two examples from seminar discourse that reflect the community's notions about equality through expertise: ideals about humility and carefulness are reflected in the way presenters give credit, and the lack of audience participation reflects a belief that the presenter is an expert.

Equality through Expertise

Examination of the math community's ideals about appropriate behavior have revealed some connections to notions of how the community regards itself and the characteristics of the subject studied. A dispreference for overt expressions of hierarchial position would seem to coincide with the characteristics of the kind of community described thus far. It would also follow that equality be valued deeply by mathematicians. This section develops the community's definitions about the interplay of equality and

expertise. An analysis of the responses to one interview question suggests that an ideal of "equality through expertise" affects math discussion. This ideal is related to the commonly expressed belief about the difficulty of mathematics and an individual's expertise that seems to transcend institutional rank positions.

A specific question in the interview schedule tried to assess how interviewees measured the impact of equality on intellectual discussions in math. Interestingly, hierarchical power relations seemed to be absent in the majority of responses. In fact, at several points during the interview schedule, responses could have included reference to status and power that emanate and is granted simply because of academic position. Generally, informants' responses did not include notions about faculty tyranny or even much concern about relations between the power-ful and the power-less. In great contrast to Tracy's informants who seemed to offer many tidy summaries of status relations and the problems of talking in the academic world where equality is valued but status remains an impediment to good discussion[25], notions of equality and expertise seem to exist differently in the math world.

There are several community ideals that specifically address equality -- math is a young person's game, give credit humbly, no one is expected to know everything about mathematics, math is hard for everyone. Perhaps the most crucial ideal when thinking about notions of equality and expertise in mathematics is that each seminar presenter is considered an expert in the topic being presented.

Quality of mathematics, not skill in verbal or written discourse, is the primary factor in judging mathematical work. And although this is typical of other academic disciplines where quality of work is valued, this is related to the tension "equality through expertise," that hierarchial positions do not impede good discussion because discussion participants may have equally valid expertises. In addition, equality can be achieved through expertise, an expertise that the person of higher academic status may not possess, and is never a static attribution set by hierarchial rank positions.

Responses to the question about equality in discussion also did not fall along strict lines about

hierarchial divisions between math talk participants. Respondents who answered "no, equality is not necessary for good discussion in math," seemed to define equality as sameness of expertise and knowledge, not institutional rank. They cited the success of collaborations as examples of how inequality of knowledge and expertises is necessary for productive and efficient discussions.

Interviewees from a range of mathematical experience believed that a level of respect and "genuine equality" or a "comfort level" is necessary for participants to have a discussion characterized by dialogue instead of "A telling B stuff," but not equality of knowledge or institutional rank.

Consider two responses to the question "is equality necessary for good discussion in math:"

> See often what happens...I think that's why collaborations are often much more efficient...because two people...they'll tend to know different things...It's just in terms of mathematical expertise, like I say, it's not unusual to see young kids explaining things to people twice, three times their age. I mean that's the way mathematics is, so, oh yeah, yeah rank or stuff doesn't hold much. (Barry, senior faculty member)

> No I don't think you want everybody to be at the same level, I mean the different levels are important, but you need an openness of communication and a receptiveness for dialogue. (Rebecca, post-doctoral instructor)

Some graduate students' responses also included references to institutional rank, suggesting it is something they are oriented to, but they also did not believe it prevented good discussion. It seems that for mathematical discussion to be productive and efficient, differences in mathematical expertise are necessary; in other words, inequality makes for good discussion. It seems it is necessary to have different knowledges and expertises in order to have a good discussion. Equality of expertise is not necessary, and equality is not defined by a common knowledge or experience but having knowledge of different things. In addition, institutional positions and status can be overcome and ignored when participants are knowledgeable and willing to engage in discussion.

Arnold's response summarizes the definitions of equality that exist in the math world, when asked "do you think equality is necessary for a good discussion in math:"

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> Hum. No....it almost never happens for one thing. I don't know what you mean by equality, but there's millions of good discussions between professors and graduate students, between junior professors and seniors professors, and so forth. Uhm. So, in that sense equality is relatively uncommon...If you can converse with somebody about a mathematical subject on the same intellectual level as them, then you're automatically equal somehow. And if, when you're done with the conversation, you are the lowly graduate student and they are the, distinguished professor or something. There's a moment of equality there when you're in conversation, at least there is, unless the people are just jerks or something. (Arnold, junior faculty member)

It seems that although institutional status and hierarchy are recognized and can become an impediment to good discussion, the people that "pull rank" are violating the community's normative ideal of equality, and thus evaluated harshly and characterized as "jerks."

Equality and expertise seem to function differently in the math world. Inequality of expertise leads to productive discussion, not to a tension between participation and idea examination in Tracy's sense. At seminar, expertise can allow an audience member to feel more comfortable participating verbally or criticizing, but interrupting and extensive commenting is viewed negatively by others. As I explain in an upcoming section, given that audience members are under no pressure to participate verbally it seems unlikely that people would feel "that all participants should speak up and be willing to risk themselves" as Tracy described.[26] In fact, seminar audience members seem to feel a tension between asking clarifying questions and preventing the presenter from finishing or other audience members from understanding. Interviewees believed they had an equal opportunity to participate in intellectual discussions when they had expertise in the topic of discussion, but at the same time they felt expertise in a different area contributes positively to discussion.

Mathematicians also felt that "ideas should be examined in light of intrinsic merit,"[27] but that seminar participation should not question the merit, or motivation, of those ideas. Examining ideas in light of a presenter's experience level begs the question because each presenter is considered an expert in the topic being presented, perhaps the only expert in the room regardless of institutional rank.

These definitions of equality and their effects on seminar participation challenge Tracy's conclusions

about tensions in intellectual discussion. In the next section, I offer two examples of how the community's notions of equality and expertise are enacted in seminar discourse, specifically how presenters position themselves and give credit to others, and how rules of participation are affected by the notion of expertise.

Positioning Self and Giving Credit

A presenter must "motivate the question" that they answer in their seminar talk, which includes putting it in a context, often historical. Part of telling the story of a question is telling about the previous work that has led to its development and why the presenter asked it. As such, the work of others is presented and explained. Whenever a theorem or equation is introduced, the author's name is stated and written on the chalkboard within parenthesis or brackets. In the case of multiple authors, the names are always listed alphabetically, not in order of contribution to the work or of hierarchial position.

Some interesting practices emerge when the presenter is the author of the work being cited. If the presenter were the sole author of the work, s/he might say something along these lines, as Adam, a post-doctoral instructor, did during a seminar:

The thing that I did a little while ago

and write on the board:

THM: [F]

This presenter was the sole author of the cited work, but did not write his complete name on the board. Instead he put the first letter of his last name inside brackets. This example demonstrates the rule that when speakers mention or explain a conjecture or proof published by them, they should not write their complete last name on the board when giving credit. If the subject of a seminar presentation was produced jointly, credit must always be given to the presenter's collaborator. When the presenter of joint work begins a talk, the collaborator's name is stated and often written on the chalkboard, usually at the beginning of the presentation. Often the collaborator's name is written prominently on the chalkboard. In another seminar, the presenter

discussed related work that had been published by himself and a collaborator. He said:

> There's another condition due to me and Williams who happened to be there at the right time to say it with me

and wrote on the chalkboard:

> P. - Williams.

Here, this presenter wrote only the first initial of his last name but the complete last name of his collaborator. His description of their collaboration is informal and conversational - they *said* it together. It is also conditional and downplays the time and effort that must have gone into the production. Although the characterization of their collaboration may be suggesting that P. was primarily responsible for the work and Williams just "happened to be there," they shared credit equally on the publication nonetheless.

Part of the ethos of the math community is a humility and carefulness that is discursively expressed in seminar through the practice of always speaking and writing the names of the researcher(s) whose ideas are being discussed or explained, and writing only the first initial of one's own last name. This was continually evident throughout all the math seminars I observed. On one occasion during a seminar, the presenter highlighted the importance of this tradition by marking her negligence to follow it. During her seminar, a visiting presenter abruptly stopped her presentation and walked to an empty chalkboard saying:

> Oh my God I can't believe I forgot to say this! All that I'm saying now is...

When she reached the chalkboard she wrote the following phrase in large letters and repeated them aloud:

> JOINT WORK
> WITH
> PETER LITTLE

Her citation remained on the chalkboard for several minutes before she erased it, and differed from others she had written in the largeness of the print. It seemed as if she were making up for forgetting to give credit to her collaborator by writing his name in big, capital letters. This citation became a marked event when she called attention to it through her interruption and by walking across the front of the room to write it. By her

own admission, she should not have neglected to mention the name of her collaborator. Noticeably, she did not state who was working jointly with Peter Little: the audience understood it was she.

Consistent across the interviews I conducted, informants stated that motivating the question constituted one of the most important components of organizing a good presentation. When motivating the question involves citing work by oneself and others, it should be done in an appropriate manner which includes being "careful" and "humble." During a seminar talk, a presenter should not write their own last name on the chalkboard. When joint work is presented, the speaker should not neglect to inform the audience and write their collaborator's name on the chalkboard.

In the next section, I describe the roles and dilemmas of audience members at seminars and how the community's values about seminar participation work to prevent audience members from participating verbally. Two major roles emerged from the interviews that differed dramatically from Tracy's site where questions and discussion are part of intellectual discussion at colloquium and participants felt pressure to ask tough and challenging questions: audience members are under no pressure to participate verbally, and questions should not interrupt the seminar and prevent the speaker from finishing. These two roles are related to the difficulty of mathematics, an estimation that all informants shared.

Roles as Audience Members

Informants seemed to share a clear standard of what a speaker ought to do in organizing and delivering a seminar presentation. Most regular seminar attenders did not report feeling concerned about their role in seminar, or even overtly aware that they had an official or unofficial role. Most commonly, people reported that they are more focused on their own comprehension to really care or even attend to what other audience members around them are doing.

Beyond the obvious desire not to appear stupid by asking a dumb question, there seemed to be at least three community ideals that prevent people from asking questions during seminar, questions that could

lead to extended discussion. For one, constantly asking questions interrupt the flow of the seminar presentation, and may prevent the speaker from finishing. The second, audience members are under no pressure to participate. Both these ideals are subsumed under the notion that because of the difficulty of mathematics, each presenter is considered an expert in the topic they are presenting.

This section outlines one of these ideals as related in the interviews and corroborated by observation at seminars. Rather than feeling pressure to ask challenging or interesting questions in seminar as Tracy's informants expressed[28], math seminar attenders felt acutely that one person should not ask too many questions and did not express feeling any obligation to ask questions as audience members, especially if they did not understand the presentation topic. Moreover, there seemed to be no pejorative judgements of people who did not participate verbally. In fact, simply showing up at seminar constitutes participation; the number of questions asked during a seminar presentation does not necessarily indicate an audience's involvement or interest.

On the other hand, in the overwhelmingly majority of seminars, few questions are asked. "I've gone to some very good seminars, with very interesting material and good speakers...there might not be any questions at all." (George, post-doctoral instructor) I also attended many seminars where only a few questions were asked, seminars that were considered exciting in informants' later accounts. So it seems the quality of a seminar presentation is judged by the content of the presentation, not by the number of questions asked. A non-pejorative evaluation of a seminar where there was no discussion coincides neatly with another community belief about mathematics itself: other subjects are more conducive to discussion than mathematics. The inherent difficulty of mathematics was also used to explain an aspect of seminar presentations that allows audience members to refrain from participating verbally, because the presenter is considered an expert in the topic they are presenting.

> I think if someone's up there giving a talk, you consider them an expert in what..it is that they're up there talking about regardless of whether they're a Fields Medalist or a graduate student. (Barbara,

post-doctoral instructor)

> I mean, it's almost like each person is like an island unto themselves with their own language...Probably the only person with a hope of understanding...their talk, without, being written, is the person who's giving it. (Rebecca, post-doctoral instructor)

Many audience members accept the likelihood that they will not be familiar with the content of a presentation. Not understanding a seminar presentation is a common occurrence, and most informants did not expect to be able to follow every seminar that they attend. Most faculty attributed this experience of incomprehensibility as part of the process of becoming a research mathematician.

> I remember as a beginning graduate student, it's completely mysterious. You go to these seminars, and you understand a fairly, extremely small percentage of what's going on. Everybody around you seems to understand and you have no idea, and you read papers. Your advisor or someone will say, "Hey have a look at this," and you look at it, and you can't get past the first sentence cause you don't understand something. And it's all a bit depressing you know. But you persevere, and then eventually one day you find you've understood something, and a week later you've understood something else. Gradually you just get into it and it's a funny process...And then after a year, you're doing just like everybody else did and (laugh) assuming that everybody knows this stuff and forgetting that at one time you didn't know. (Barry, senior faculty member)

Somehow these community values about mathematics combined with a sincere love of the subject keep people attending seminars. For graduate students especially, this belief may serve to keep them from becoming too frustrated with not understanding, but becoming familiar with feeling frustrated may be part of the process of doing mathematics. Andrew Wiles, who recently solved one of math's oldest unsolved theorems, described doing mathematics this way:

> Perhaps I could best describe my experience of doing mathematics in terms of entering a dark mansion. One goes into the first room, and it's dark, completely dark. One stumbles around bumping into the furniture, and gradually, you learn where each piece of furniture is, and finally, after six months or so, you find the light switch. You turn it on, and suddenly, it's all illuminated. You can see exactly where you were.[29]

Mathematicians spend a lot of time not knowing what they are doing or if they are following the correct path to a result; they spend a lot of time thinking that they're stupid and not knowing what they're doing,[30] reinforcing the belief about the difficulty of math and a humility towards the subject.

In addition to the purposes of seminars for beginning mathematicians that informants uniformly identified -- teaching novices about how to present mathematics, how to select a research area, what is a good and interesting question -- seminars also teach novices how it feels viscerally to do research mathematics.

In this section I have outlined the rules about audience participation and the community's ideals that define the role of audience members. The ideals are described at the beginning of this section, but in reality they are inter-related. A concern for the speaker seems to guide the rules about which and how many questions should not be asked. A concern for fellow audience members, on the other hand, explains the kinds of questions that audience members should ask. Audience verbal non-participation can be understood in light of informants' beliefs about the difficulty of mathematics, as can the infrequency of discussion during seminar be explained by ideals about not distracting or interrupting the speaker and fellow audience members. Notions of expertise and equality interplay throughout these community ideals and do not correspond to hierarchial academic positions as they did in Tracy's study.[31] Further study may reveal that they instead reflect ideals of the cognitive sciences in general.

Conclusion

The math community's definitions of intellectual discussion and the tensions they face can contribute to the sketches of academic discussion that Tracy proposed in her book, Colloquium: Dilemmas of academic discourse. The math community's definition of equality and expertise is put into practice at weekly topical seminars. Their widespread belief that differences of expertise that each person may have regardless of institutional rank contributes to productive discussion and influences rules and roles about seminar participants. Other people's expertise should always be cited clearly and carefully -- a presenter should give credit to other authors' work by writing their last names on the chalkboard, and joint work must be noted by giving credit to one's collaborator. Expertise is highly specialized, to the extent that the speaker may be the only expert in the room: as a result, audience members are under no pressure to participate because it is

common and acceptable not to understand a presentation. In addition, the speaker's expertise and right to have it should not be jeopardized by continued questioning which can interrupt the speaker, distract other audience members, and prevent the speaker from finishing the presentation.

In many ways, mathematics is a social pursuit. Communication, and "talking math," is a valued component of doing math. Seminars play a part in mathematical research departments worldwide, and represent both an appreciation for informal talking and its place in the research process. They also play a role in socializing apprentice mathematicians into the community.

As a site for acculturation into the math community, seminars function quite effectively, evidenced by the almost uniformity of informants' responses about the purposes of seminars and appropriate actions for presenters and audience members' questioning behaviors. Weekly, each group's seminar offers a place where members can hear about current research and catch up on their colleagues' recent results. Rules of participation in math seminar, whether through questioning or simply attending, are shared. Apprentice mathematicians learn what questions are interesting to work on at the same time they learn how to talk about math. Audience members observe and absorb both good and bad techniques for motivating a question, at the same time they learn the history of their field. As the community participates in seminar, beliefs about equality and expertise are passed on and reinforced.

Intellectual discussion in this context does not to conform to the contours Tracy used to define it for her ethnographic site at a Speech Communication Department:

> Most basically, intellectual discussion is a talk occasion in which the primary focus is on ideas. Furthermore, the ideas are ones of some abstraction...In addition, participants are expected to explore differences of opinion when, at least in principle, they are open to changing their minds as a result of talking. Finally, the occasion is valued as an end in and of itself, not simply as a tool to be used to accomplish other ends such as making a decision, or teaching information to another.[32]

Although seminar talk matches some of these features, some fundamental differences remain. The major purpose of math seminar, as identified by regular participants, is to learn about new results and to teach

information to one another. A basic belief about mathematics is behind the rules for seminar and discussion: although talking can change people's ideas about the truth-content of a proof, it is not primarily talking that will convince people, rather it is the content of a proof. Seminars participants are not interested in exploring differences of opinion, especially during seminar. Differences of opinion are specifically not seen to figure into discussions about math or the truth-content of a proof.

Intellectual discussion in the academy, then, does not conform to any one definition and does vary from Tracy's definition. It has been argued that discussion in the sciences should not be considered academic discussion because it is "doing science" or engaging in "professional talk."[33] Distinctions between these kinds of talk are arbitrary and meaningless, especially in this community where intellectual discussion incorporates notions about "doing science" and "professional talk."

Whether intellectual discussion in the cognitive sciences conforms to any one definition and practice, however, remains to be fully explored. Sally Jacoby and Patrick Gonzales, in their paper "The constitution of expert-novice in scientific discourse,"[34] concur with the findings presented in this report about the relationship between equality and expertise in discussion. Their paper examines talk in interaction from informal discussions of a working group of physicists who each represent a range of institutional rank positions. Using the method of conversational analysis, they found that "expert-novice relationships in unfolding interaction are not necessarily functions of *a priori* macro-level social categories of hierarchial status,"[35] rather they are created through a dynamic shifting of expertise and individual knowledge.

Jacoby and Gonzales' study explains how participants momentarily construct and reconstruct identities of expert and novice in talk. They state: "this is not surprising if we consider that each member of the group is a specialist in his or her own work regardless of professional seniority."[36] Although they use examples from talk in interaction to demonstrate the same notions of the "equality through expertise" ideal explained in this paper, they do not consider that this is a belief always and already present in scientific, and

mathematical, discussions before the start of any interaction. This may be the most important feature to consider when analyzing talk in the sciences.

Nonetheless, this paper is an honestly rendered ethnographic description of the mathematical seminar and community beliefs about communication and discussion. An ongoing goal in the mathematical community has been to increase minority success in mathematics. Students who participate in seminars have successfully progressed through the department's requirements to begin research for their Ph.D. However, the notions about equality which are pervasive in formulations of the ideals of mathematical discussion, do not figure into the steps through which a student/apprentice must pass before arriving at the point where equality may be granted by acquiring varying expertises. The equal opportunity inherent in these ideals, and so much a part of the community, may be key to successfully promoting equal access to knowledge and good discussion.

Endnotes

1. Tracy, K. Colloquium: Dilemmas of academic discourse.

2. p. 6, ibid.

3. p. 4, ibid.

4. Grimshaw, 1989 and 1994, Collegial discourse: Professional conversation among peers, and What's going on here.

5. Potter, 1984, "Testability, flexibility: Kuhnian values in scientists' discourse concerning theory choice," and McKinlay & Potter, 1987, "Model discourse: Interpretative repertoires in scientists' conference talk."

6. This is Tracy's term for McKinlay and Potter's "science" talk. p. 7, Tracy, K., Colloquium: Dilemmas of academic discourse.

7. C.P. Snow's controversial essay, "The Two Cultures" first published in 1959, is perhaps the most well-known example. A short, incomplete list of two other authors are Roman Ingarden who contrasted literature with scientific texts, and Donald Polkinghorne who used cognitive psychologist Jerome Bruner's dichotomy to discuss regular, everyday narrative and meaning-making with the logico-scientific or "paradigmatic" mode.

8. Sal Restivo summarizes and criticizes these studies in his book, Science, Society, and Values: Toward a sociology of objectivity, esp. chapter 5, "The Anthropology of Science." Sharon Traweek also summarizes these studies in "An introduction to cultural and social studies of sciences and technologies," in Culture, Medicine and Psychiatry. See also: K.K. Cetina, S. Franklin, J.H. Fujimora, I. Hacking, and A. Pickering.

9. For example, Bentley, Linguistic analysis of mathematics, Ernest, Social constructivism as a philosophy of mathematics, Fang, J. & K.P. Takayama, Sociology of mathematics and mathematicians: A prolegomenon, and Livingston, E., The ethnomethodological foundations of mathematics.

10. p. 250. Restivo outlines a radical sociology of mathematics, in which "*all* talk is *social*; the person is a *social structure*; and the intellect (mind, consciousness, cognitive apparatus) is a *social structure*." (p. 248) Although he advocates this sociology as a way to consider the production of mathematical forms and objects, he recommends "despiritualizing technical talk" to focus on the sociality of mathematics and production of mathematical knowledge. The research presented in this paper focuses on a different aspect of social talk in the math world, but I believe it supports his assertion that "math worlds are social worlds" (p. 269). Restivo, S. "Social life of mathematics." In Math worlds: Philosophical and social studies of mathematics and mathematics education.

11. p. 80. Tracy, K. Colloquium: Dilemmas of academic discourse.

12. p. 83, ibid.

13. p. 85, ibid.

14. p. 82, ibid.

15. p. 32, ibid.

16. From the schedule posted on the Math Department Web Page, http:\\www.ma.utexas.edu\weekly-calendar.text.

17. In "The work of Mary Ellen Rudin," Franklin D. Tall describes how one seminar was formed: "In 1971 Ken came back from a year at Berkeley with Bill Fleissner and Judy Roitman in tow, and - **having attained critical mass** - he and Mary Ellen started a seminar in set-theoretic topology for their students and visitors." (p. 9) [emphasis added] This quote illustrates both the organic nature of seminar creation, as well as purposes of a seminar. From The work of Mary Ellen Rudin, F.D. Tall (Ed.).

18. "This is but another aspect of the vital importance of informal, spoken communication. For in formal papers it is far more difficult to attain clarity." (p. 47) The author also offers guidelines to aid good scientific communication: "Above all, a good scientific meeting must not be over-organized. It is essential for the scientists to drift about aimlessly in small groups, talking about this and that. Only in this way can the necessary informal communication be established." (p. 46) Bondi, H. "Why scientists talk." In The languages of science: A Survey of techniques of communication. See also D.C. Pelz and F.M. Andrews.

19. As is the case in Pohnpein society described in "A woman's role in constructing status hierarchies: using honorific language in Pohnpei, Micronesia," by E. Keating, International Journal of the Sociology of Language 129.

20. p. 59. Spradley, J.P. Participant observation.

21. p. 54, ibid.

22. pp. 167-173. Tracy, K. Colloquium: Dilemmas of academic discourse.

23. p. 293-4. Cicourel, A. V. "The Interpenetration of communicative contexts: examples from medical encounters." In A. Duranti & C. Goodwin (Eds.) Rethinking context: language as an interactive phenomenon.

24. The interviews were transcribed in a manner to represent the aspects of the talk as discourse, including mis-starts and repairs, verbal fillers and non-fluencies. Most of these aspects are removed from the excerpts presented in the report, except when the aspects themselves are analyzed as part of the message of the interview response.

25. The second section of her book, which covers "dilemmas of the group," are explained "in terms of two sets of tensions. Interviewees believed both that ideas should be examined in light of intrinsic merit (ignore the rank of presenter), and that they should be examined in light of a presenter's experience level (attend to rank). The second set of tensions revolved around participation practices. Interviewees believed both that participation should be guided by a person's topic knowledgeability, and at the same time that all participants should speak up and be willing to risk themselves." p. 79-80. Tracy, K. Colloquium: Dilemmas

of academic discourse.

26. p. 80, ibid.

27. p. 79, ibid.

28. ibid.

29. Dr. Andrew Wiles, in the Nova presentation, "The Proof." (1997, October 28). Written and produced by John Lynch.

30. Paraphrased from an un-taped interview with Dr. J. Dollard.

31. Tracy, K. Colloquium: Dilemmas of academic discourse.

32. p. 6. Tracy, K. Colloquium: Dilemmas of academic discourse.

33. Tracy cites Grimshaw (1989, 1994) and Potter (1984) who studied professional talk at a dissertation defense and psychologists' discussion at academic conferences respectively.

34. Jacoby, S. and Gonzales, P. "The constitution of expert-novice in scientific discourse." Issues in applied linguistics 2.

35. p. 173, ibid.

36. p. 165, ibid.

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